IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

APPLICANTS: NEUGEBAUER ET AL - 1 PCT (RCE)

SERIAL NO: 10/588,692   EXAMINER: Melanie Jo. HAND

FILED: DECEMBER 14, 2006   GROUP: 3761

TITLE: FASTENING TAPE FOR A HYGIENE ITEM, DIAPER, METHOD
               OF CLOSING A DIAPER, TAPE MATERIAL AND WINDING OF
               A TAPE MATERIAL

DECLARATION OF *Constanze Behrmann* UNDER 37 C.F.R. § 1.132

MAIL STOP RCE

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Commissioner:

I, *Constanze Behrmann*, hereby declare as follows:

1.   I am *exec. manager Patents and Reg. Affairs* at Koester GmbH & Co.

KG, the assignee of the above-identified United States Patent

Application Serial No. 10/588,692. I am a German citizen and my

address is *Friedrichstr. 9*, D-*96047 Bamberg*, Germany.

2.   [Set forth Education/Employment Experience,

Professional Accomplishments]

*Graduate engineer of process technology for plastics
and paper converting*

1987 - 1991 University of applied science, Munich, Germany

*Engineer responsible for the development of adhesive
tapes (esp. closure tapes for baby diapers)*

since 1992 at Koester GmbH & Co. KG

3. I have been made familiar with and understand the disclosure of the above-identified '692 patent application and the invention as recited in claim 84.

4. The invention as recited in claim 84 is directed to a diaper having a fastening tape including a closing area for simultaneous detachable joining to a surface of the diaper. The closing area includes a first area having a shear-off securing component of a two-component mechanical fastening system and a second area having a pop-off securing fastener. The pop-off securing fastener includes an adhesive layer with an adhesive adhering to a back sheet of the diaper with a separation force of more than 0.05 N/cm^2.

5. I have been made familiar with and understand the final Office Action dated May 3, 2010 which was received in the above-identified patent application.

6. In the May 3, 2010 Office Action, referring to former claim 59 directed to a diaper wherein the pop-off securing fastener comprises an adhesive layer comprising an adhesive adhering to a back sheet of the diaper with a separation force of more than 0.05 N/cm^2, the Examiner has deemed the disclosure insufficient to enable a person skilled in the art to make a

diaper having the specified range for the separation force for the adhesive adhering to the diaper. See page 3 of the May 3, 2010 Office Action. The Examiner has also taken the position that there is no explicit correlation between materials used and/or structural features and any peel force of any magnitude in the specification and has disagreed that "referring one of ordinary skill in the art to several unrelated foreign prior patents would enable that person to make or use the instantly claimed invention in any way." See page 2 of the May 3, 2010 Office Action.

7. To demonstrate that this assumption by the Examiner is incorrect, attached is *Handbook of PSA Technology* evidencing that any person skilled in the art is able to vary the separation forces between any fastening tape and a corresponding back sheet in a fairly wide area. As indicated in *Chapter 5, "Peel"*, there are a huge number of different adhesives and mixtures of adhesives that a person skilled in the art might use in order to set the separation forces according to a certain value. In my experience, it is just a matter of a few tests to compare a certain behavior at separation while testing some different adhesives or adhesive mixtures and is something that is routinely and easily done.

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8. Thus, from my experience, instructing a person skilled in the art to use an adhesive that would adhere to the back sheet of the diaper with a separation force of more than 0.05 N/cm^2 is all that the person would need to select a suitable adhesive that has the specified separation force in order to construct and use the diaper recited in claim 84 in which the pop-off securing fastener includes an adhesive layer comprising an adhesive with this property.

I further declare that all the statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the likes so made are punishable by fine or imprisonment or both under §1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of any patent granted on the above-identified application herein.

Dated: November, 2nd, 2010

Constanze Bebre
_____
[NAME]

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5. Peel

Donatas Satas
Satas & Associates
Warwick, Rhode Island

One of the often measured characteristics of pressure sensitive adhesives is the resistance to peel that is determined by measuring the force required to peel away a strip of tape from a rigid surface. Resistance to peel is also called peel adhesion and peel force. The term peel adhesion is probably used most frequently, although objection could be made to the accuracy of such a term. Adhesion denotes a state in which two surfaces are held together, rather than the force required to break them apart. The peel force, as measured by the test, is a function of many factors, not only of the interfacial adhesive bond.

Peel resistance data can yield more information about the adhesive character and its expected performance than other commonly used tests of pressure sensitive products: tack and resistance to creep. However, peel resistance does not necessarily relate to the adhesive performance, and it should not be assumed that the peel resistance and the strength of the adhesive bond are synonymous. Peel is a special type of failure that might not relate to many other ways of failure that might take place in use.

MODE OF FAILURE

The standard peel tests are carried out at a constant peel rate, and it is expected that a pressure sensitive adhesive tape will strip cleanly from the adherend, leaving no visually noticeable residue. This type of failure is called adhesive failure, and it occurs at or near the adhesive–adherend interface.

Some adhesives may also fail cohesively, leaving adhesive residue on the test panel. If the adhesive has not firmly adhered to the backing, it may transfer to the test panel, leaving no adhesive on the backing. The magnitude of the peel force depends on the mode of failure, and it should be clearly stated if
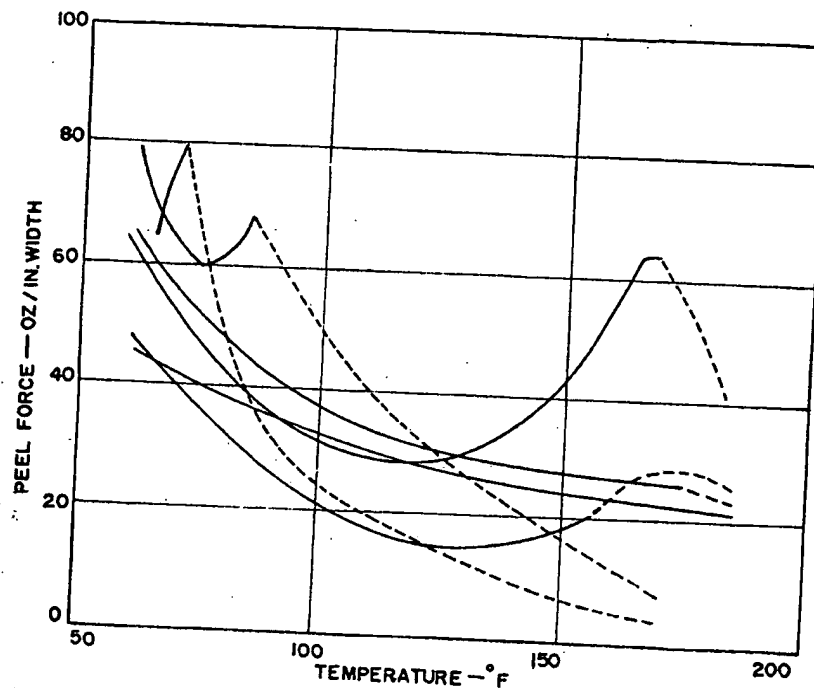
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Fig. 5-16. Peel force of adhesives with various degrees of ionic binding. Sodium content: *curve top right*, 0.500%, 0.34%, 0.69%, 0.18%; *curve bottom right*, 0% (Satas and Mihalik[36]).

The peel force versus temperature are different for polymers with different degrees of cross-linking, or hydrogen and other secondary bonding. An increased degree of cross-linking increases the splitting temperature. Acrylic polymers containing carboxylic groups were treated with Na ions in order to affect ionic binding.[18] Figure 5-16 shows the peel force versus temperature curves for polymers with various degrees of ionic binding. The dotted line denotes cohesive failure.

Gerace[35] has presented T-peel data as isocleaves at varying peel rates and temperatures for an acrylic and a butyl rubber adhesive.

EFFECT OF ADHESIVE THICKNESS

It is known that peel adhesion increases with increasing adhesive thickness and levels off at some thickness, usually in the range of 50 μm (2 mil). Table 5-4 shows the peel adhesion data reported by Chan and Howard,[36] where the peel adhesion appears to level off at 30 μm (1.2 mil). Similarly Johnston[37] has reported a leveling of the peel force at about 50 μm (2 mil), as shown in Figure 5-17. The dependence of peel force on adhesive thickness has been discussed by many other researchers.[6,28,38-42]

Table 5-4. Variation of
Peel Strength with
Adhesive Thickness

THICKNESS (μm)	PEEL STRENGTH (N/m)
7.6	201–15
10.2	323–91
15.2	511–11
22.9	565–18
30.5	560–52

Other researchers have shown data where the peel force was affected by adhesive coating as thick as 200 μm.[43] Druschke has shown that peel adhesion and quick stick increase with the coating weight beyond a thickness of 25 μm,[6] as shown in Figure 5-18.

The stresses are transmitted through the adhesive to the backing. The adhesive is deformed and the force required to deform the adhesive contributes to
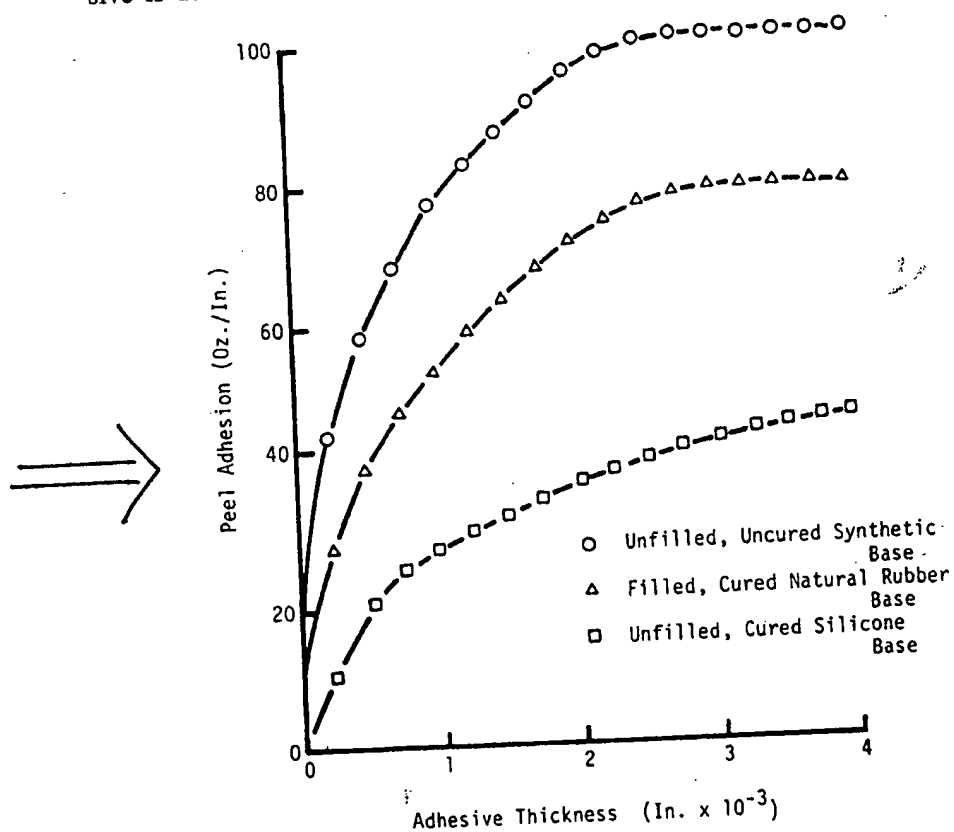
Fig. 5-17. Effect of adhesive thickness on peel force. Backing: 12 polyester film.

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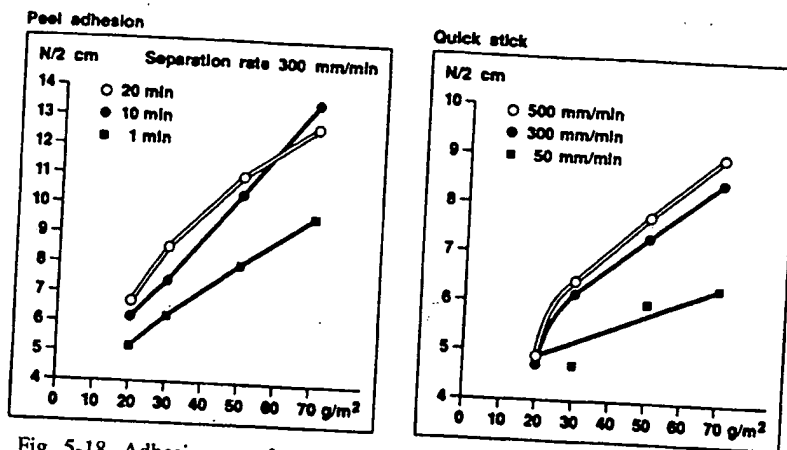rates:
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Fig. 5-18. Adhesion as a function of coating weight. (Courtesy BASF A.G.)

the measured peel force. The deformation is higher near the adhesive–adherend interface, and it becomes less severe at the points further away from the locus of failure. Eventually an adhesive thickness is reached where no further deformation takes place, and thus the contribution to the total peel force becomes negligible. Thus the leveling of the peel force will be reached at a lower adhesive thickness for firmer, higher modulus adhesives than for softer adhesives.

The adhesive thickness has a twofold effect on the peel force. Heavier adhesive coating increases the volume of adhesive under deformation, thereby increasing the peel force. It also increases the total thickness of the tape, and the effect is similar to that of increased backing thickness, which causes a lowering of the peel force, especially at 180-degree peel test conditions.

Increase of the adhesive thickness causes a shift of the cohesive–adhesive failure transition in the peel-force–peel-rate curve (Fig. 5-7) to higher peel rates.

A number of analytical expressions have been proposed showing the dependence of peel force on the adhesive thickness. Gardon[40] has shown that at high thickness values

$$P = \alpha t_a^{0.25}$$

where

(4)

P = peel force

t_a = adhesive thickness

α = parameter dependent on substrate thickness, adhesive, and substrate moduli

At low adhesive thickness peel force is proportional to $t_a^1 - t_a^{0.25}$. Similarly, Bikerman[41] has shown that $P \sim t_a^{0.25}$.
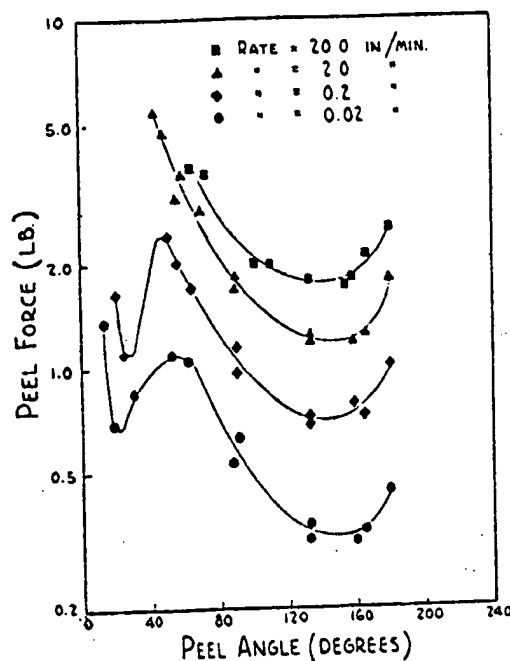
Fig. 5-24. Peel force as a function of peel angle for a glass cloth tape. (Reprinted from *Transactions of the Society of Rheology* **IV**: 45–73 (1960).)

discrepancies, such as maxima-minima observed at 30–40-degree peel, as shown in Figure 5-24.[47] These discrepancies are attributed to the transition of the failure mechanism from cleavage to boundary shear. All tapes displayed a minimum of peel force at angles of 120–140 degrees.

The effect of peel angle has also been discussed by Gardon.[48] The effect of peel angle, especially peeling at 90 and 180 degrees, on the deformation of the backing and consequently on the peel force, has been discussed by Gent and Hamed.[45]

EFFECT OF ADHESIVE COMPOSITION

Bulk adhesive properties, that is, storage and loss moduli, have an effect on peel adhesion, since most of the work during peeling is expended in deforming the adhesive. Increasing molecular weight and increasing degree of cross-linking are expected to cause a decrease in peel adhesion. The effect of molecular weight in case of acrylic adhesives is shown in Table 15-2. The effect of molecular weight was also discussed by Aubrey.[13,38] Figure 5-25 shows 90-degree peel data of poly(butyl acrylate) adhesive of varying molecular weight and degree of cross-linking.[13] Increase of molecular weight increases the modulus
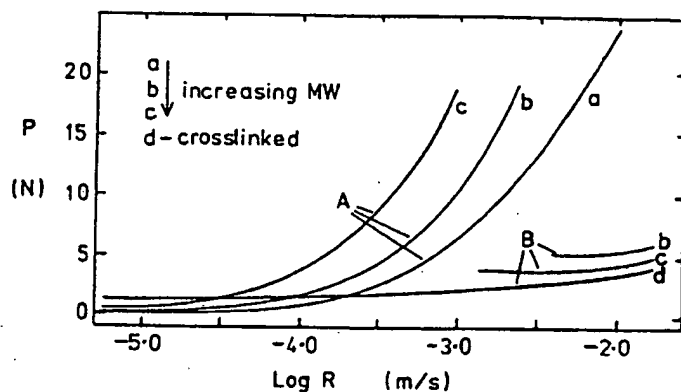
Fig. 5-25. Peel force vs. peel rate for a polybutyl acrylate. (A) Cohesive failure; (B) adhesive failure. (Reprinted from reference 12, p. 25).

of elasticity and decreases the polymer chain mobility. This causes an increase of peel force in case of cohesive failure, but a decrease in the region of adhesive failure. Harder, less extensible adhesive results in a smaller adhesive volume being deformed at any time during peeling and a lower peel force. The increase of molecular weight has a most noticeable effect on the splitting temperature: transition temperature from adhesive to cohesive failure as shown in Figure 15-3.

Figure 5-26[49] shows peel force data of two 0.1-mm-thick soft aluminum foil tapes. Tape A has a soft uncross-linked acrylic polymer adhesive, while tape B has an adhesive of similar composition, but cross-linked and considerably more elastic. It is obvious that these two curves represent different sections of the generalized peel-force–peel-rate curve shown in Figure 5–7. Curve A is the steady peel and curve B is the nonrandomly oscillating peel-force portion of the generalized curve. The solid line denotes steady peel force, and the discontinuous line denotes oscillating peel force.

Figure 5-27[49] shows the unwind of polyethylene coated fabric tapes. Tape C has a soft natural rubber-resin adhesive; tape D, a cross-linked natural rubber-resin adhesive; tape E, an acrylic polymer adhesive. The data illustrate the shift of the transition point to the higher peel rates with decreasing elasticity of the adhesive.

The effect of hydrogen bonding on the peel force is similar to that of cross-linking and is discussed in Chapter 15 on acrylic polymers. It has been shown that the introduction of hydrogen bonding via acrylonitrile comonomer increases polymer stiffness. Figure 15-9 shows the effect of acrylonitrile on penetrometer compliance, illustrating its stiffening effect. The peel behavior of these polymers is shown in Figure 5–28.[49] The decrease of peel force and the shift of the transition point is affected by the increasing acrylonitrile content.

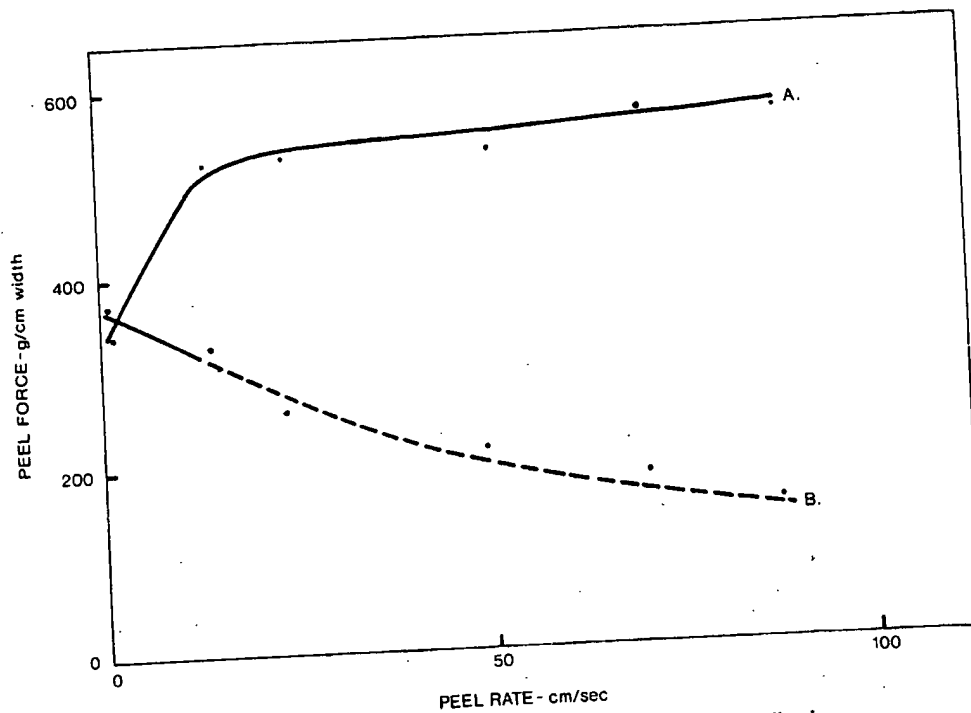Mao and Reegan[50] have shown the dependence of peel force on the type

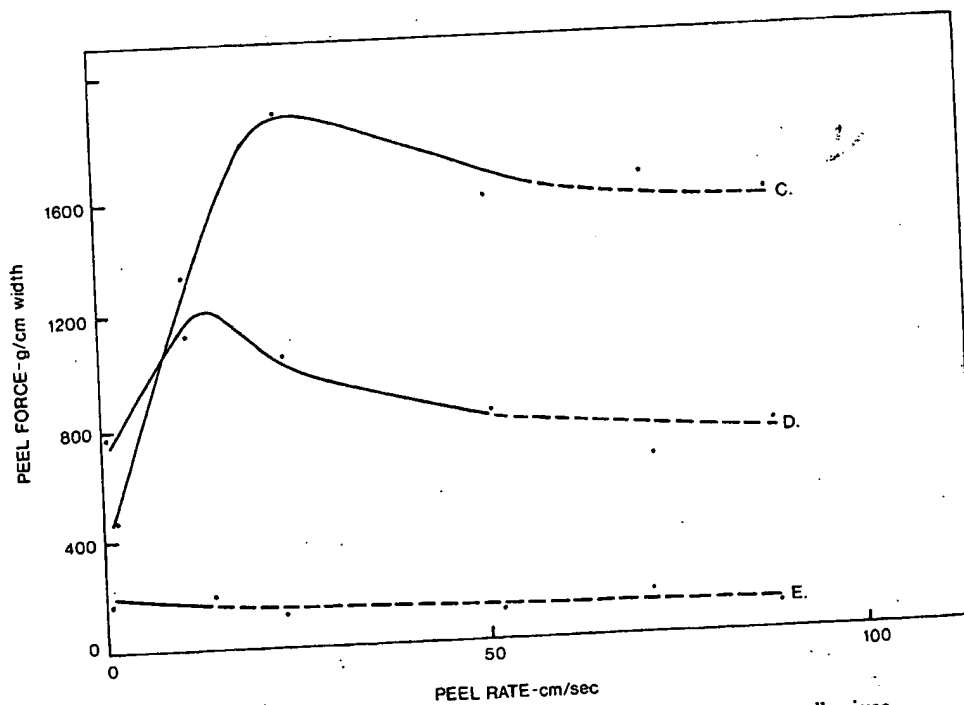Fig. 5-26. Peel force aluminum foil tapes with two different adhesives.

Fig. 5-27. Peel force of polyethylene coated fabric tapes with different adhesives.
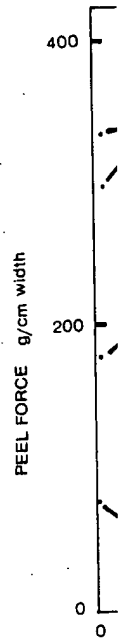
Fig. 5-28.
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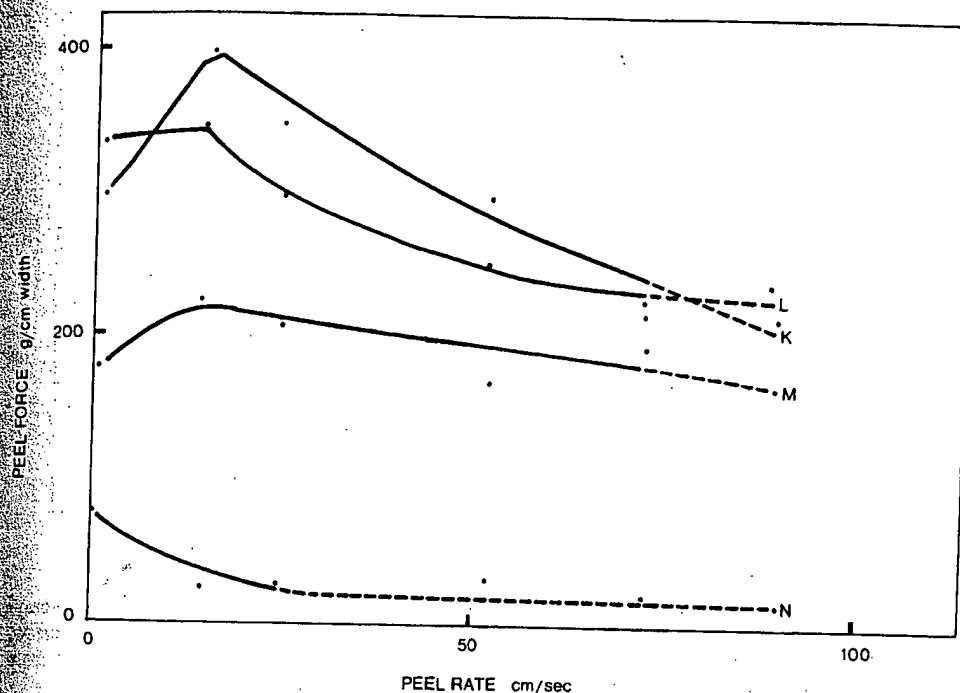the diff
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Fig. 5-28. Effect of acrylonitrile on peel force. Amount of acrylonitrile: (K) 0%; (L) 1%; (M) 2.5%; (N) 10%.

of comonomer used in acrylic polymers. Aubrey[13] has discussed the effect of an adhesive's glass transition temperature in acrylic-vinyl acetate copolymers of varying composition. An increase of T_g causes a lateral shift of the peel-force–peel-rate curve to the left. The comparison of peel-force–peel-rate curves for polybutyl acrylate and vinyl acetate indicates a shift over 12 decades.

Introduction of carboxylic groups into the adhesive polymer chain is known to increase the peel adhesion, and this is effectively used in acrylic and SBR pressure sensitive adhesives. Part of this effect may be attributed to the interfacial effects, that is, improved wetting, but the most important part is due to the effect of bulk adhesive properties. Aubrey and Ginosatis have investigated the effect of carboxylic groups on the peel force.[51] The authors made an attempt to distinguish between bulk and interfacial effects by preparing layered adhesives. A sample was prepared with carboxylated adhesive on the surface and a noncarboxylated one in the bulk; another set of samples was prepared in the opposite manner. The test results are shown in Figure 5-29. The differences between curves a and b and between curves c and d reflect the interfacial effects, while the difference between curves a and c and b and d reflect the bulk effects. The contributions to the peel force are not constant, but are rate dependent. The sum of the bulk and surface contributions of carboxylation gave curve e, which closely matches experimental curve d.

EFFECT OF INTERFACE
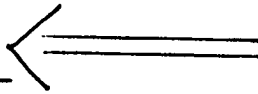
Peel work consists of two main components: the work required to deform the adhesive and the backing, and the work required to debond the adhesive from an adherend. Usually the bulk effects dominate the pressure sensitive adhesive behavior, and the contribution of interfacial effects is of a smaller magnitude. This relationship, however, changes drastically if the adhesive does not wet the surface well. In such cases, the interfacial adhesion becomes dominant.

The interfacial processes may affect the bond in several ways:

1. Improved wettability may increase the contact area between the adhesive and the adherend, and consequently increase the measured peel force.
2. Additional bonds, that is, hydrogen or chemical bonds, may be established, supplementing the van der Waals forces.
3. The adhesive may or may not be compatible with the impurities on the adherend surface. A compatible adhesive dissolves the impurities, thus increasing the bond strength.

The time period required to establish the proper bond and to reach a constant level of peel adhesion depends upon the adherend surface and upon the flow characteristics of the adhesive. The bond is established faster to a smooth surface than to a rough one. Hendricks and Dahlquist[11] have shown that a time period of one to two days is sufficient to establish a good contact to most relatively smooth surfaces, but it might take much longer to achieve a constant peel level to a porous surface, such as wood. The bond might continue to increase over a long period of time, if other factors, besides wetting, become important in the formation of the bond.

Figure 5-31 shows the peel force as the function of peel rate of an aluminum foil tape to various release coatings.[49] All four tapes had the same adhesive of the same thickness. The difference in the observed peel force is due to the different release levels. It is of interest to observe that the differences in the release levels appear to decrease with increasing peel rate. Silicone release coated tape (curve R) shows a very easy release at low peel levels, but that advantage is lost as the peel rate increases. For a minimum of flagging when the tape is overwrapped on itself, a higher peel force at low peel rates is desirable. Therefore, such effective release coatings as silicone are rarely used for tape backings. For easy dispensing of tapes or labels at high peel rates, a low peel force at high peel rates is desirable.

Peel adhesion is usually measured by applying the tape to a standard steel surface. Adhesion to other surfaces might be important for many applications. Pressure sensitive labels are often tested against steel and against polyethylene surfaces. All adhesives show a lower peel adhesion to polyethylene than to
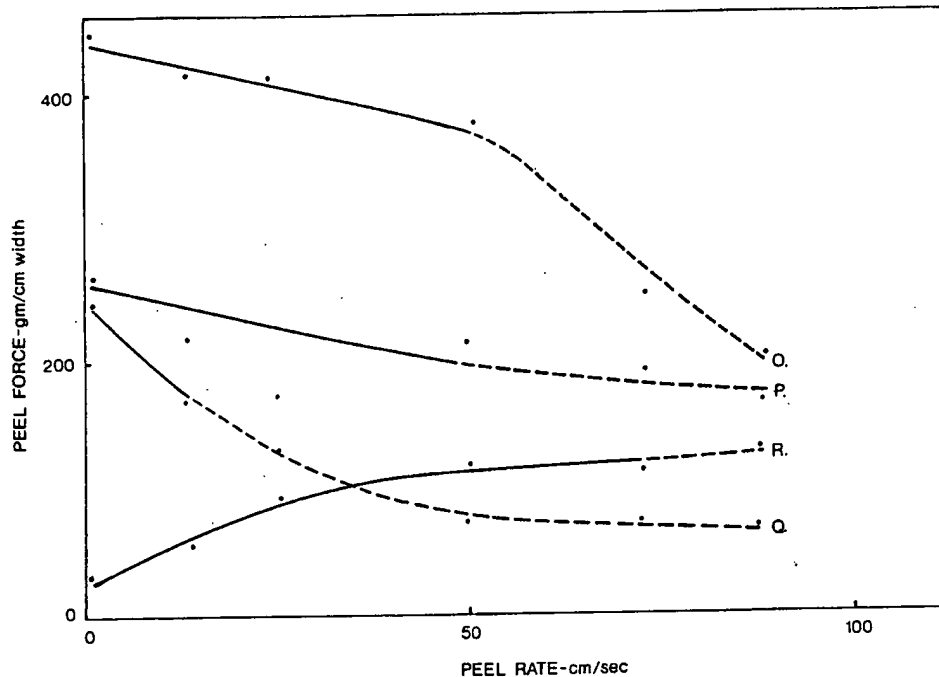
Fig. 5-31. Effect of release coatings on peel. (O) Acrylic release coating; (P) Quilon C release; (Q) polyethylene release coating; (R) silicone release coating.

steel, because a polyethylene surface is more difficult to wet. Polar acrylic adhesives may exhibit 50% lower peel adhesion to polyethylene than to steel or other higher critical surface tension surfaces. This difference can be decreased by the addition of tackifying resin, which improves wetting.

STRESS DISTRIBUTION

The distribution of stresses in the adhesive bond must be considered in order to gain a better understanding of the test and of the relation of peel force to the properties of pressure sensitive adhesives. It has been recognized by DeBruyne[52] and discussed by many other authors that compressional stresses are developed in the adhesive during peeling.

An apparatus for measuring the normal stresses during peeling of an adhesive bond has been described by Johnson and Kaelble[53] and later discussed in greater detail.[54] Figure 5-32 shows a schematic diagram of such an apparatus designed for mounting on an Instron Tester. The substrate to which the adhesive tapes is applied is divided into two parts. The rightmost section is rigidly supported and its position is insensitive to the normal forces of peel. The substrate to